Experimental and Research Station,

Nursery & Market Garden Industries' - - Development Society, Limited, - -

Turner's Hill, Cheshunt, Herts.

Third Annual Report, 1917.

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Nursery and Market Garden Industries' Development Society, Limited.

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* Nominated by the Committee of the Lawes' Agricultural Trust, Rothamsted, Harpenden, Herts.

† Nominated by the Lea Valley and District Nurserymen's and Growers' Association, Limited.

Experimental and Research Station.

DIRECTOR.

A. B. LISTER, D.I.C., B.Sc. (Lond.).

RESEARCH ASSISTANT FOR SOIL STERILISATION.

* MRS. D. J. MATTHEWS, M.Sc. (Vict.).

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Laboratory and Office Assistant—Helen Marchant.

GLASSHOUSE WORKING STAFF.

Foreman .....‡A. A. Richards.
Cucumber Grower.....†J. H. Smith.
Tomato Grower.....†R. Creighton.

*Working for the present at the Rothamsted Experimental Station.
‡Away on National Service.
†Ineligible for Military Service.

Diagram —
— To show arrangement of experimental plots
— 1917 —

General Report.

THE management of the Experimental and Research Station, established in 1914, was delegated to a new Society under the name of the Nursery and Market Garden Industries' Development Society, Limited. This Society now consists of 115 Share-holders, holding 358 Transferable Shares as against 69 Share-holders, holding 69 Shares in 1914. Of the 115 Share-holders, 107 are Annual Subscribers to the Experimental Station Maintenance Account, which has risen from £209 in 1914 to £259 in 1917. During the last three years £107 has been added to the Capital Account, which now stands at £2,676, the net deficit to date being £610.

In common with other Institutions and trade nurseries, the Station has been severely handicapped by Military requirements in the matter of manual labour. No one has been appointed in the place of the Station foreman, Mr. A. A. Richards, who left in January, 1917, and the remainder of the working staff has been subject to many changes. Sixteen of the men employed at various times during the last three years are now on National Service.

During the year 1917 the number of reports, circulars, notices, letters, &c., despatched exceeded 6,000. Of these, 474 were reports by the Director of a strictly scientific or technical nature, 356 being sent to growers in the Lea Valley district, and 118 to growers in other parts of Great Britain. At the request of members, the Director visited 95 nurseries, 89 in the Lea Valley district and 6 outside. The number of visits has been considerably curtailed, as the unskilled nature of the working staff has necessitated continual supervision by the Director at the Station.

Visits to nurseries are regarded by the growers as an important part of the work of the Station, at any rate in the Lea Valley district, where, according to

statistics supplied to the Director by the courtesy of the Overseers of local parishes, there are nearly 1,000 acres of glass.

The number of visits from growers (or their representatives) and other interested persons during the year amounted to 1,183.

Various experiments have been conducted in the laboratory during the year: the practical applications of these, however, have to be tested before any announcement can be made.

Thirty samples of soil were examined with regard to lime requirements, the soils of the Lea Valley district proving remarkably deficient in this respect.

In connection with the growing interest in allotment-culture many enquiries were answered; considerable assistance was rendered to allotment-holders, chiefly with reference to potato-spraying, the Station providing materials for making Burgundy Mixture at cost price, and lending spraying machines free of charge.

The experimental work has, to a large extent, been a continuation of that undertaken in the previous year. New features were the growing of potatoes under glass, as an additional crop before planting tomatoes; an experiment in slow versus forced growth of tomatoes; and some experiments conducted at two trade nurseries on the effects of various sterilising agents on tomato soils.

The Committee gratefully records that Mr. W. B. Randall has generously provided funds for the establishment of a new research post, to which Mrs. D. J. Matthews, formerly Miss A. Isgrove, has been appointed. Her work will consist in the study of some of the problems connected with soil sterilisation as it is now being carried out in the Nurseries, and the investigations will be carried out, in the first instance, at the Rothamsted Experimental Station.

Experimental Records and Tables.

Sources of Error and Uncertainty.

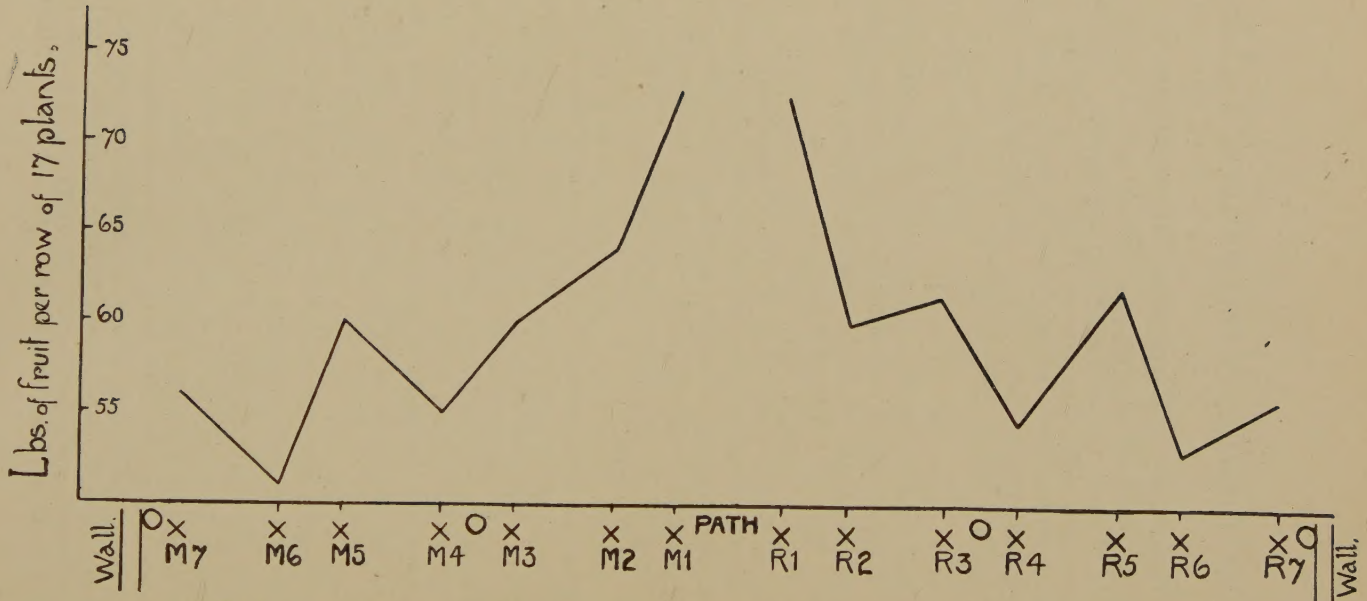
That the plants at or near the hotter end of a house do better than those at the coolor end, is well known. The manurial experiments with cucumbers (Table VI.), wherein there were similar plots at both ends, give a measure of the difference in that particular case. The percentage excess of yield from the plots at the hotter ends were :—

D1,	D6,	F1,	F6,	E1,	E6,	C1,	C6.
−12	+12	+24	−10	+8	+15	+16	+5

giving a mean of +7. Subtracting this mean from each of the observed differences the residues will represent the errors due to chance differences in the individual plants, and these, set out in their order of magnitude, are

−19, −17, −2, +1, +5, +8, +9, +17

the arithmetical mean of which is 10. The existence of such errors renders it necessary to exercise more than usual caution in drawing conclusions. Roughly speaking, it would be unwise to accept as significant any differences much below 20 per cent. unless supported by contributory evidence. With tomatoes, as far as can be judged by the instances available, the difference due to the plots being at opposite ends of the house is quite as great as in the case of cucumbers, and one experiment with tomatoes points to the existence of a further source of uncertainty. Two similar plots facing each other in one of the houses (Series M. and R.) were planted and grown under similar conditions, the crops from each row of 17 plants running lengthwise in the house being recorded separately. The appended diagram represents a section of the house, with the position of the plants indicated. The zig-zag lines represent the crops from each row, and it is evident that the behaviour of the plants in the two plots is closely similar. There is a very high yield from the rows next to the path, which is only what is usually found in the case of all outside rows in plots; but, apart from this, all the other rows show alternately high and low values, with differences extending up to 20 per cent. This alternation can have no connection with the incidence of light, nor with the hot-water pipes, the positions of which are shown, and is perhaps indicative of some beneficial condition operating from the centre of the house towards the sides, the plants in the rows 2, 4 and 6 being partially shaded from it by their neighbours, which are closer to them on the side nearer the centre than on the other side. Of course, a prejudicial



Relative positions of plants (X), and hot-water pipes (O).

condition operating from the sides towards the centre, would equally explain the facts, but is less probable, as the house is an outside one, and the two sides, therefore, are not similar.

It is evident that a more extended investigation of the behaviour of plants, both cucumbers and tomatoes, according to their position in the house, is desirable.

Double Cropping—Potatoes and Tomatoes.

Half of one of the tomato houses was devoted to an experiment on growing potatoes prior to the planting of the tomatoes, so as to ascertain whether such double cropping would pay. Four varieties of potatoes were taken; the sets were planted, after sprouting, on January 29th, and the crop was lifted on May 7th. Each plot was then put down to tomatoes, the same variety being planted throughout. From 5 to 7¾ tons per acre of potatoes were obtained, and 21 to 24 tons of tomatoes, the variations in the latter, however, showing no connection with those in the former (Table I.). As 35 to 40 tons of tomatoes per acre were obtained in adjoining houses when they occupied the ground the whole time, the double cropping represents a loss of about 12 tons of tomatoes, with only about 6 tons of potatoes as compensation.

Table I.

POTATOES.					TOMATOES.		
VARIETY.	No. of sets.	Space per set.	Yield.		VARIETY.	Yield.	
			Per plot.	Per acre.*		Per plant.	Per acre.*
		sq. ft.	lbs.	tons.		lbs.	tons.
"Eclipse"	142	2	73	5.0	"Comet".	3.06	21.4
Sharpe's "Express"	284	1	112	7.7	Do.	3.40	23.8
"Duke of York" ...	284	1	112	7.7	Do.	3.00	21.0
"British Queen" ...	142	2	86	5.9	Do.	3.23	22.6

* In all the Tables the yield per acre is calculated from the total area of the houses including paths, &c.

Slow versus Forced Growth of Tomatoes.

This experiment was conducted in the Isolation House. It had been decided that this house should be devoted to experiments with infected soils in pots, but, owing to unforeseen difficulties, these had to be abandoned, and the experiment on slow *versus* forced growth was substituted. The Isolation House is divided by a glazed partition into halves: in one of these a high temperature was maintained and a liberal allowance of

water was given,* whilst in the other half, the temperature was lower, and less water was given, the manurial treatment in each case being the same. Unfortunately the experiment was started late (planting out done on April 4th), and also, the plants suffered from an overdose of lime previously dug in; so that no very definite conclusions can be drawn this year, and the experiment, which is considered to be an important one for the district, will have to be repeated.

So far as the present results (Table II.) go, they indicate that the increased cropping induced by the forcing does not extend beyond about the first two or three weeks, after which the unforced plants forge ahead, and retain their superiority sufficiently to show an excess of 9 per cent. in the total crops for the season. The relative values for each month are given at the bottom of the Table, as well as the actual crop in tons per acre, from which every grower will be able to judge for himself which treatment is likely to pay him best.

Table II.

Crops in lbs. per plant, on plots (17 ft. by 8 ft.) containing 54 plants, and occupying 1/290th of a house-acre.

VARIETY.	Forced Growth.							Slow Growth.						
	June.	July.	August	Sept.	Oct.	Total. lbs. per plant.	Total. Tons pr acre	June.	July.	August	Sept.	Oct.	Total. lbs. per plant.	Total. Tons pr acre
"Fillbasket" ...	0.48	1.13	0.96	0.91	0.48	3.96	27.7	0.16	2.33	1.61	0.81	0.23	5.13	35.9
"Comet"	0.30	1.46	0.82	0.75	0.52	3.85	27.0	0.05	1.59	1.52	0.73	0.20	4.09	28.6
"Kondine Red"	0.75	1.83	1.03	0.76	0.52	4.89	34.2	0.11	1.63	1.58	0.79	0.20	4.31	30.2
"Ailsa Craig"...	0.50	1.28	0.74	0.81	0.38	3.71	25.9	0.03	1.68	1.40	0.81	0.35	4.27	29.9
Relative Values	100	100	100	100	100	100	—	17	127	172	97	51	109	—
Tons per acre ...	3.5	10.0	6.2	5.7	3.3	—	28.7	0.6	12.7	10.7	5.5	1.7	—	31.2

Soil Sterilisation Experiments at Two Trade Nurseries.

The Committee of Management decided that it was essential to carry out some experiments on partial sterilisation of glass-house soils, as far as possible under trade nursery conditions, to ascertain the values of the various methods and

*In this part of the Isolation House a light overhead damping was given on bright days between 10 and 11 a.m. when the temperature was rising to about 85°F., but no ventilation was given unless the temperature still rose and exceeded 90°F., when a little was given for a few hours. Very little more water was given to the roots than in the other half of the Isolation House, and when four trusses had set, the overhead damping was gradually discontinued In dull, close weather, and during the summer, both parts were treated practically alike. The object of the treatment was to secure an earlier and more valuable crop by "bottling-up" or taking fuller advantage of the sun-heat. The night temperature was maintained at 60°F. in both parts.

materials commonly in use. The soil at the Station is, at present, free from serious infection, and the introduction of "sick" soil was considered undesirable from many points of view. Under the circumstances, it was agreed that the best way to carry this work to a satisfactory conclusion would be to treat the soils on some trade nurseries with different agents, and to leave the entire cultivation to the growers, thus ensuring that the crops were grown under normal nursery conditions. This year the experiments were confined to tomato soils.

By the courtesy of two members, three large tomato houses were placed at the disposal of the Committee of Management. Eight plots were set out in each of two of these houses, and the following treatments were given: Steam (two plots); hot water; naphthalene (four ounces per square yard); formaldehyde (one-ninth gallon of 40% solution per square yard); lime (4 lbs. per square yard); commercial pale straw liquid "carbolic acid" (more appropriately termed coal tar acid; it consists mainly of cresylic acid) 97/99% (one-ninth gallon per square yard). One plot was left untreated in each house. In the case of Nursery No. 1, one-eighth of an adjoining house was treated with cold water, applied in the same way as the hot water in the other house. The plots were kept under observation by Members of the Committee. At No. 1 nursery, where the houses were 18 years old there was a good deal of root-knot eelworm *(Heterodera radicicola)*; at No. 2 nursery which was 11 years old the soil had no particular pest, but had shown a steady decrease in cropping power over a number of years, in spite of adequate manurial treatment, being what is technically known as "sick."

In considering the results, which are set out in Table III., it must be remembered that the action of a sterilising agent may be very complex. It may increase the fertility of the soil generally by improving the bacterial conditions; it may act directly on the malady from which the soil is suffering, and, if through imperfections in the method of application, some of it is left in the soil, it may have an effect (generally deleterious) on the growth of the plant: in view of which latter consideration it is possible that a treatment which is effective in remedying the malady, may reduce the crop in the season of its application. With such complications, many years' work must be required to supply satisfactory information.

The present results indicate at first sight that "carbolic acid" has given good results in both nurseries, that formaldehyde and steam have done so in one nursery, whilst cold water has done the same in the only nursery in which it was tried; all the other treatments being ineffective or actually deleterious.

Table III.

Soil Sterilisation Experiments.

At nursery No. 1 the houses each measured 198 ft. by 27 ft. 6 in. (area =605 square yards=one-eighth of an acre). The variety grown was "Kondine Red," the plants numbering 280 per plot (49 ft. 6 in. by 13 ft. 9 in.), 2,240 per house, 17,920 per acre. At the conclusion of the experiments the roots were examined for "club." The cleanest roots came from the plots treated with formaldehyde, "carbolic acid" and steam, in the order mentioned.

At nursery No. 2 the house measured 237 ft. 8 in. by 27 ft. (area =713 square yards). The variety grown was "Kondine Red," the plants numbering 330 per plot (59 ft. 5 in. by 13 ft. 6 in.), 2,640 per house, 17,920 per acre.

TREATMENT.	Yield per plant.					Total.		Relative.
	June.	July.	Aug.	Sept.	Oct.	Lbs. per plant.	Tons per acre	
Nursery No. 1. House A.								
"Carbolic Acid".	0.98	1.72	0.64	0.76	0.50	4.60	36.8	107
Formaldehyde ...	1.09	1.63	0.61	0.70	0.42	4.45	35.6	103
Steam	0.53	1.64	0.69	0.67	0.53	4.06	32.5	94 | 95
*Steam	1.00	1.36	0.65	0.72	0.40	4.13	33 1	96 |
Lime	0 96	1.50	0.51	0.75	0.37	4.09	32.7	95
*Hot water ...	0.93	1.45	0.63	0.71	0.43	4.15	33.2	96
Naphthalene ...	0.66	1.54	0.52	0.86	0.38	3.96	31.7	92
Untreated ...	1.23	1.46	0.49	0.76	0.36	4.30	34.4	**100**
Nursery No. 1. House B.								
*Cold Water ..	0.95	1.38	0.72	0.51	0.44	4.00	32.0	‡107
Untreated ...	0.82	1.18	0.60	0.56	0.57	3.73	29.9	**100**
Nursery No. 2.					†			
"Carbolic Acid".	0.89	1.15	0.60	0.68	0 44	3.76	30.0	111
Formaldehyde ...	0.59	0.86	0.55	0.60	0.51	3.11	24.9	92
*Steam	0.77	1.23	0.84	1.01	1.01	4.86	38 9	144 | 126
Steam	0.77	1.10	0.66	0.55	0.56	3.64	29.1	108 |
Lime	0.75	0.89	0.57	0.64	0.51	3.36	26 9	99
*Hot Water ...	0.65	1.05	0.56	0.55	0.45	3.26	26.1	96
Naphthalene ...	0.68	1.00	0.60	0.59	0.57	3.44	27.5	102
Untreated ...	0.66	0 93	0.53	0.59	0.67	3.38	27.1	**100**

* Plots at boiler end of house.

† Including small weights picked in November.

‡ If compared with the nearest untreated plots this value becomes 105.

On closer examination, however, doubts must arise as to the trustworthiness of any of these results. In two cases (steam) there were duplicate plots, one at the hotter, the other at the cooler end of the house, and the differences between them amount to as much as 9 and 36 per cent. in favour of the hotter ends, a value sufficient to outweigh all the differences observed in other cases, and rendering any conclusions very doubtful. As regards the steam-treated plots, it is evident that the first one in nursery No. 2 is altogether exceptional, and must be discarded, leaving only a doubtful balance in favour of

steam-treatment in that nursery, and none in nursery No. 1; whilst the low results with hot water should apparently be still lower, since in both cases the plots in question were at the hotter ends of the houses. This leaves only "carbolic acid" and cold water as the two forms of treatment which may have produced good results.

Experiments in the Management and Cultivation of Tomatoes.

Six varieties were grown this year in connection with the experiments on "stopping" *versus* "non-stopping," begun in the previous year. The two series came out almost identical in total crop return (Table IV.), 100 as against 99, though the stopped plants showed a superiority of 15 per cent. as regards the yield for June. The variations in the monthly yields are, however, probably only accidental. More space will be devoted to this experiment in the coming season.

Table IV.

Crops in lbs. per plant. Each plot contained 18 plants and occupied 1/871 part of a house acre.

VARIETY.	"Stopped."							"Non-Stopped."						
	Lbs. per plant.					Total.		Lbs. per plant.					Total.	
	June.	July.	Aug.	Sept.	Oct.	Lbs. per plant.	Tons pr acre.	June.	July.	Aug.	Sept.	Oct.	Lbs. per plant.	Tons pr acre.
"Ailsa Craig" x Bucks "Tresco"	1.59	3.81	1.30	0.31	0.38	7.39	51.8	1.53	3.38	1.32	0.49	0.40	7.12	50.0
"Romford" x "Ailsa Craig"...	1.80	2.07	0.66	0.22	0.41	5.16	36.1	1.60	2.82	1.02	0.41	0.38	6.23	43.6
Rochford's Improved "Ailsa Craig" ...	1.97	2.09	1.15	0.40	0.38	5.99	42.0	1.54	2.13	0.89	0.19	0.18	4.93	34.5
Balch's Seedling A1 .	1.10	1.78	1.07	0.24	0.44	4.63	32.4	0.81	2.06	1.02	0.13	0.18	4.20	29.4
,, ,, A3 .	0.98	2.00	0.57	0.31	0.15	4.01	28.1	0.93	2.29	0.69	0.23	0.09	4.23	29.6
,, ,, A4 .	1.09	2.24	0.68	0.07	0.27	4.35	30.4	0.83	2.49	0.77	0.17	0.33	4.59	32.2
Relative Values... ...	100	100	100	100	100	100	—	85	108	105	104	77	99	—

The experiment on overhead damping *versus* dry treatment, and their relative effects on the setting of the fruit, was repeated this year. The plots were transposed, the damping being done in the house that was kept dry last year, and *vice versa*. The results (Table V.) differ from those obtained in 1916, for on both occasions the same house gave the larger yield, irrespective of the treatment. Two explanations of this are possible. It is well known that some houses will give a larger yield than others over a period of years, even under similar treatment. On the other hand, the treatment itself may have

varying effects according to the season. In 1916 the weather in the spring was persistently wet, and the house that was not specially damped then gave the better result; in 1917 the spring was notably dry, and the damped house gave a better yield. As regards this season's results the balance is in every respect in favour of the house which happened to be damped, for not only has it resulted in an increase of 10 per cent. on the total crop, but also in more than doubling the crop in June, when prices are highest (see last line of Table V.). There may be some correlation between these phenomena. It is too early to make any definite statement on the matter, and the experiment will be repeated.

Table V.

"Fillbasket" and "Ailsa Craig" on plots (40 ft. by 12 ft. 6 in.) containing 180 plants, and occupying 1/87th of a house-acre.

"Comet" and "Tuckswood" on plots (60 ft. by 12 ft. 6 in.) containing 270 plants, and occupying 1/58th of a house-acre.

VARIETY.	House not Damped.							House Damped.						
	Lbs. per plant.					Total.		Lbs. per plant.					Total.	
	June.	July.	Aug.	Sept.	Oct.	Lbs. per plant	Tons per acre.	June.	July.	Aug.	Sept.	Oct.	Lbs. per plant	Tons per acre.
"Fillbasket" ...	1.02	2.86	1.33	0.87	0.26	6.34	44.4	1.71	2.50	1.08	0.94	0.26	6.94	45.5
"Ailsa Craig" ...	0.82	2.85	1.08	0.66	0.18	5.59	39.1	1.55	2.59	1.03	0.83	0.24	6.24	43.7
"Comet"	0.59	2.22	1.08	0.52	0.22	4.63	32.4	1.78	1.97	0.98	0.72	0.31	5.76	40.3
"Tuckswood"...	0.70	2.70	1.26	0.68	0.28	5.62	39.4	1.49	2.24	1.03	0.86	0.39	6.01	42.1
Relative Values.	46	115	115	80	77	90	—	100	100	100	100	100	100	—

The Manurial Experiments.

Owing to the circumstance that the Station soil still retains much of its virgin character, it could hardly be expected that the manurial experiments would lead to any very definite conclusions as yet. Certain results are beginning to emerge, however, which are probably not accidental.

Three distinct series of experiments are in progress. In the first and second the object is to discover the fertiliser requirements of cucumbers and tomatoes respectively, grown under glass—the commonest crops in this district. The third is more local in interest, and is confined to tomatoes. It consists in applying in varying proportions a dressing selected by growers as a "standard."

(a) The Manuring of Cucumbers.

The experimental results given in Table VI., bring out very strikingly the great need which cucumbers have for some dung and that neither hoofs, bone-meal, nor a mixture of the two can be substituted for it. The effect of the dung, however, is by no means proportional to the amount used, the results given in Table VI. showing that 50% is only questionably more efficient than 33%, and that, when the percentage is raised to 67%, there is a considerable fall in the yield (the results in this latter case, however, being not strictly comparable with those in the others, owing to the houses being dissimilar). Thus—

	No dung.	Dung 33%.	Dung 50%.	Dung 67%.
No hoofs, &c.	100	149	146	117
With hoofs, &c.	100	145	159	—
Mean	100	147	153	—

Last year the adverse effect set in before 50 per cent was reached.

Doubtless the value of the dung is largely physical, in promoting openness of the soil and in warming the border as it decomposes.

Where half the border was dung the soil temperature rose higher, being, on an average, 74°F. as against 64°F. in the case of the 33 per cent. dressing. There was also better root-action and quicker growth. On the other hand the stems were thinner, and there were fewer laterals—12 as against 14 on April 4th -indicating less robust growth than where one-third of dung was used. It is easy to conceive circumstances in which this might be a disadvantage, and hence the difference observed in the results for these two years. The results with hoofs, &c., are quite negative and may be thus summarised—

No hoofs, &c.	Hoofs.	Bone-meal.	Hoofs & bone-meal.
132	145	130	139
or 100	110	98	105

Thus hoofs give no crop-increase outside the limits of the experimental error; so, also, bone-meal which is much used by growers, has proved ineffective. This raises the question whether growers are justified in continuing bone-meal for cucumbers, and whether meat-meal or fish-meal might not prove more suitable to use. Both hoofs and bone-meal made the foliage firmer and more robust. On the other hand, the quickly-acting nitrogenous manures lengthened the internodes and gave longer-jointed growth. In this connection it is interesting to note that baked soil, which is rich in quick-acting nitrogenous compounds, shortens the internodes.

Table VI.

Manurial Experiments with Cucumbers.

In Series D., E. and F., crops in lbs. per plant, grown in borders (32 ft. by 3 ft.) containing 16 plants, and occupying 1/210th of a house acre.

In Series C, crops in lbs. per plant, grown in borders (24 ft. by 3 ft.) containing 12 plants, and occupying 1/290th of a house acre.

TREATMENT. (Lime added in all cases.)	Lbs. per plant.				Total.		Relative.		Relative compared with D1 & 4.
	April.	May.	June.	July.	Lbs. per plant	Tons per acre			
D. No dung.									
1. No hoofs nor bone-meal ...	2.56	8.42	5.46	4.85	21.3	32.0	94	100	100
4. ,, ,, ,, ...	4.03	8.55	6.15	5.37	24.1	36.2	106		
2. Hoofs	4.11	9.86	6.61	5.02	25.6	38.4		113	113
6. Bone-meal	5.41	9.42	6.63	5.94	27.4	41.1	120	114	114
3. ,, ...	3.23	10.5	5.76	4.81	24.3	36.6	108		
5. Hoofs and bone-meal ...	4.08	9.31	7.06	5.55	26.0	38.8		114	114
F. Loam 2 parts, dung 1 part.									
1. No hoofs nor bone-meal ...	8.53	13.6	8.04	7.83	38.0	57.0	112	100	149
4. ,, ,, ,, ...	3.51	12.9	7.46	6.03	29.9	45.0	88		
2. Hoofs	7.39	13.4	7.76	6.55	35.1	52.6		103	
6. Bone-meal	5.39	12.2	6.98	5.63	30.2	45.3	89	94	140
3. ,, ...	6.53	13.2	7.69	6.08	33.5	50.1	99		
5 Hoofs and bone-meal ...	5.69	13.6	7.55	5.26	32.1	48.1		95	141
E. Loam 1 part, dung 1 part.									
1. No hoofs nor bone-meal ...	9.04	10.1	8.31	7.14	34.6	51.9	104	100	146
4. ,, ,, ,, ...	5.93	10.7	8.09	6.98	31.7	47.7	96		
2. Hoofs	9.30	11.7	9.30	7.60	37.9	56.8		114	167
6. Bone-meal	8.28	11.1	8 06	8.26	35.7	53.4	108	100	146
3. ,, ...	6.53	8.73	8.56	6.68	30.5	45.9	93		
5. Hoofs and bone-meal ...	8.32	11.6	9.26	7.92	37 1	55.7		112	163
C. Loam 1 part, dung 2 parts.									
1, No phosphates	1.85	10.4	8.19	7.46	27.9	41.7	108	100	117
4. ,, ...	0.37	8.21	7.78	8.94	25.3	38.1	92		
2. Superphosphate	1.76	10.8	8.22	9.62	30.4	45.6		114	
6. Bone-meal	1.79	8.38	7.04	8.59	25.8	38.7	97	95	100
3. ,, ...	0.18	7.91	7.98	8.23	24.3	36.6	92		
5. Basic Slag	0.80	10 7	7.93	9.37	28.8	43.2		108	127

* Due allowance being made for the smaller number of plants per plot in C.

The ineffectiveness of the phosphates in these experiments, which was equally apparent in the previous year, is rather surprising, and it seemed so important that a separate experiment was made to test the point. The borders were made up with loam and various phosphates, and were then top-dressed with a mixture of one part of loam to two of straw manure, together with the particular kind of phosphate. Superphosphate, bone-meal and basic slag were used on separate plots, but no increases were observed beyond the limits of the experimental error, the results in the case of superphosphate, with an increase of 14 per cent., being the best (last column but one in the Table).

(b) The Manuring of Tomatoes.

As in the case of cucumbers, two distinct problems were investigated: the manurial requirements of the tomato, and

the sufficiency or otherwise of the dressings usually regarded as necessary in this district.

Owing to the circumstance that a tomato house is run on less intensive lines than a cucumber house, it is possible to design a useful experiment much more on the lines of an agricultural experiment than can be done in the case of cucumbers. The conditions are still, of course, far removed from those in agriculture; the yields are much higher and the dressings of manure are far greater. If individual artificial fertilisers were used (as in the case of the simple manurial scheme of an agricultural field trial), there would be considerable danger of secondary physical effects being produced on the soil, and these would complicate the issue. In order to avoid this, the manures are used in combinations in which the secondary effects are known to be reduced to a minimum. Thus, instead of using either nitrate of soda alone (which when used in considerable quantities is known to leave an alkaline residue in the soil), or sulphate of ammonia alone (which is known to leave an acid residue), a mixture of the two is used which leaves neither an acid nor an alkaline residue, and neither injures the texture of the soil nor exhausts its lime. So also, instead of using superphosphate alone, a mixture of superphosphate and basic slag is used. In this way the side issues are obviated, and we are able to deal with the one problem of the nutrition of the plant.

The plan of the experiment is to have a completely manured plot, also plots from which each of the three fertilising constituents, nitrogen, potash and phosphates, is successively left out, so as to ascertain which of them first shows itself as the limiting factor in tomato production.

The results from the two series, with different varieties, are satisfactorily concordant, and the mean is given in the last column of Table VII.

Starting as we did with a virgin soil, it was not to be expected that any limiting factor would declare itself in the first season. This year, however, there are signs that a limiting factor is beginning to show, and, though it is too soon to be sure that the result is a real one, a certain tailing-off as regards the potash is probable, for on the plot receiving no potash the crop was less than on any of the others, this result not being obtained last year.

On the other hand, the withholding of nitrogen not only caused no falling off in crop, but gave an actual gain, though of a magnitude too small to be considered as certain. This result was also obtained last year, and the fact that the addition of

dung to the complete artificials gave no appreciable crop increase, supports this observation, as also do the remaining experiments in Table VII.

Table VII.

Manurial Experiments with Tomatoes.

Crops in lbs. per plant, grown on plots (25 ft. by 12 ft.) containing 108 plants, and occupying 1/145th of a house-acre.

PLOT NUMBER AND TREATMENT. *	Series J. Variety "Comet."							Series K. Variety "Kondine Red."							Mean of Two Series.
	Lbs. during				Total.		Relative.	Lbs. during				Total.		Relative.	
	June.	July.	Aug.	Sept.	Oct.	Lbs. per plant	Tons per acre.		June.	July.	Aug.	Sept.	Oct.	Lbs. per plant	Tons per acre.		
5 Complete Artificials ...	1.68	1.67	1.05	0.29	0.42	5.11	35.8	100	1.01	2.44	1.07	0.58	0.54	5.64	39.5	100	100
6 Artificials without phosphates; no dung.	1.68	1.69	0.91	0.27	0.43	4.98	34.9	97	1.02	2.63	1.01	0.64	0.53	5.83	40.8	103	100
7 Artificials without nitrogen; no dung	1.70	1.99	1.12	0.39	0.40	5.60	39.2	110	1.26	2.32	1.16	0.58	0.76	6.08	42.5	108	109
8 Artificials without potash; no dung	1.30	1.89	0.81	0.32	0.33	4.65	32.5	91	1.03	2.36	1.04	0.33	0.42	5.18	36.2	92	92
4 Complete Artificials with added dung... ...	1.52	1.69	1.28	0.48	0.38	5.35	37.5	105	1.26	2.50	1.13	0.49	0.33	5.71	40.0	101	103
2 Half-standardManurial Treatment	1.36	1.78	0.82	0.25	0.40	4.61	32.2	90	0.83	2.23	1.27	0.49	0.51	5.33	37.3	95	93
1 Standard Manurial Treatment	1.01	1.60	0.98	0.21	0.23	4.03	28.2	78	1.01	2.20	1.01	0.50	0.44	5.16	36.1	91	85
3 Double-standard Manurial Treatment	1.32	2.12	1.19	0.38	0.42	5.43	38.0	106	1.15	2.59	1.01	0.61	0.36	5.72	40.1	101	104

*For details of manurial dressings see page 31.

Turning to these, a "standard dressing" representing the best collective experience of the district was drawn up by a Sub-Committee of practical growers. One plot received this in the

proportions recommended, another received half the quantity, and a third received double the quantity. Last year all three gave the same yield; this year the results were equally negative, but were not concordant in themselves; for whilst the double dressing gave an appreciable increase in crop, the single dressing did not give such good results as the half dressing; the crops, as the dressing was increased, being in the proportion of 93 : 85 : 104 or 109 : 100 : 123. Both varieties show these peculiarities, but more markedly so in the case of "Comet," and in this case, the peculiarities are observable in the returns for every month except August. It is unfortunate that the arrangement of the plots with the two varieties was the same in both houses; still, no connection can be traced between the peculiarities observed and the position of the plots as regards proximity to the hotter ends of the houses.

The materials composing the standard dressing are lime, dung, bone-meal, steamed bone-flour, ground hoofs and sulphate of potash. It is too soon yet to make a close analysis of the results, but it may be noted that the artificial manures on plot 7 (lime, phosphates and potash, but no nitrogen) proved more effective than even the double amount of standard dressing, although they were only added in quantities equal to half of the standard dressing. These artificials have produced the best results of any, and all the attempts to increase the yield by adding a quickly-acting nitrogenous manure have failed.

The contrast between such a result and that obtained in the case of cucumbers, is highly suggestive; it may be merely a consequence of the greater drain on the soil due to the production of a greater weight of fruit, but, on the other hand, it may indicate fundamental differences in the mode of nutrition of these two plants. Probably we shall not get a satisfactory answer to this question till we examine the effect of manures on the whole plant, and not merely on the weight of fruit produced.

Physiological Conditions in Cucumber Houses.

Work on the physiological conditions in cucumber houses was continued by Mr. F. G. Gregory. In the second Annual Report the results of preliminary work on the physiology of cucumbers were published. The striking feature of these results was the apparent relationship in time which was observed between the periods of active vegetative growth and of fruit production (see Fig. 1). This result suggested further investigation of the relationship, and the work was undertaken in the season 1916-1917. Many of the data collected have unfortunately been lost, so the work done cannot be fully presented.

Growth increments per 24 hrs. in mms.
Average Wt. of fruit produced per day by 36 plants.
Carried back 27-28 days in time
Growth per 24 hrs in Mms
Lbs wt of yield of fruit
5·0
4·0
3·0
2·5
2·0
1·5
1·0
25
20
15
10
5

Fig. 1

The general scheme consists in accumulating data of the varying physical conditions, *e. g.*, temperature, light and humidity, and studying their effects on the plants as shown, on the one hand, by growth-rates of stems and of leaf surfaces as indicative of vegetative activity, and, on the other hand, by fruit production. The method is to study intensively a few plants, and thus to discover relations between external conditions and the phenomena of growth and reproduction; to these relations numerical values may be attached. This method has the great advantage of enabling one to make deductions from the behaviour of plants under their normal conditions of growth; it avoids subjecting them to the artificial conditions necessary if the effect of a single factor is to be studied by itself.

Batches of seedlings were raised at various periods from December to June under cultural conditions such as obtain in working nurseries, and were allowed to grow for a period of thirty days. During this period records of humidity, temperature and light were taken. At the end of the period the plants were carefully washed free of soil, dried at 100°C., and afterwards weighed. To determine the regular increase of the leaf area a formula was devised so that, by taking three linear and two angular measurements of each leaf, the area could be calculated with tolerable accuracy. Every leaf was measured daily during the period of 30 days. At the end of this period the actual leaf surface of each plant was determined by taking tracings of the leaves on ground glass, transferring to tracing paper, and measuring with a planimeter. This actual area was compared with the calculated one, and so the error of calculation became known. Thus, for every day the average area of leaf surface per plant was known, and a curve could then be constructed showing the growth in leaf area. This curve was found to be irregular to some extent, but from the figures the irregularities were smoothed out, and a curve was obtained which fitted as closely as possible on the actual curve derived from the calculated figures. From this curve the acceleration in the increase of the leaf surface was found, and also the average leaf area of the plant during the period of 30 days.* If then we divide the dry weight of the plant by the average area of leaf surface and the number of hours of light, a figure is obtained which represents the average rate of increase, per unit area, per hour, of the dry

*The importance of knowing this average leaf surface depends on the following consideration. As all the carbon of the food manufactured by the plant can be traced back to the leaves, the total dry weight of the plant at the end of the period may be taken, without serious error, as a measure of the activity of the leaves during the whole period (neglecting the weight of material lost by respiration). Now the leaf area is continually increasing during the 30 days, but the average gives us such an area that if we could imagine a plant maintaining a constant leaf surface of this area during the whole period, its dry weight at the end would be the same as that of the real plant.

weight of the plant over the whole period. This method gives us a ready means of obtaining the average rate of assimilation over long periods of time, and at different seasons of the year, assuming that dry weight is proportional to carbon assimilation, and that all the leaves are equally active in assimilation.

In the experiments, batches of 20 seedlings were used, ten of which were measured every day, and their dry weight determined at the end of 30 days. The others were planted out in the borders. The lengths of the internodes of the stem were taken at the time of planting out. While the main stem was growing to the top of the house the length was taken each day, and so the rate of growth of the main stem for each day was found. The date of the first fruit, and later the weight of fruit from each plant, were recorded separately. It was noticed that if one arranged the plants in order of their stem length at the time of planting out, they kept the same order in relation to both the date at which the stems reached the top of the house and the total weights of fruit produced. The variations in plants in these respects must be familiar to all growers, and the fact that they are correlated is of interest. It seems possible that a commercial variety, *e. g.*, "Butcher's Disease Resister," may include several strains, each of which breeds true; if so, it ought to be possible to separate these by noting differences in growth rates, and thus to obtain strains which not only grow more rapidly, but yield better crops. The importance of stem growth in its bearing on fruiting is not generally realised, but it is obvious that the number of shoots on the plant determines the possible number of fruits which can be borne; also the date of the "first flush" depends on the time taken for the main stem and laterals to develop. There was found to be an appreciable correlation between the area of the seed leaves and of the first "rough leaf," and also a small correlation between the size of the seed leaves and the dry weight after 30 days. We can thus to some extent forecast the future efficiency of a plant from the seedling stage. These facts are clearly of importance in relation to any work which may be undertaken on the heredity of the cucumber.

It was found that the rate of growth of the stem was correlated with the minimum temperature (see Figures 2 and 3), and not with light; but, on the other hand, the variations in the rate of increase in leaf area per day during winter months are correlated with the total amount of light per day, so that with high temperatures light becomes a limiting factor, *i.e.*, although other conditions are favourable, the growth is limited by the deficiency of light. Evidence of this appears below.

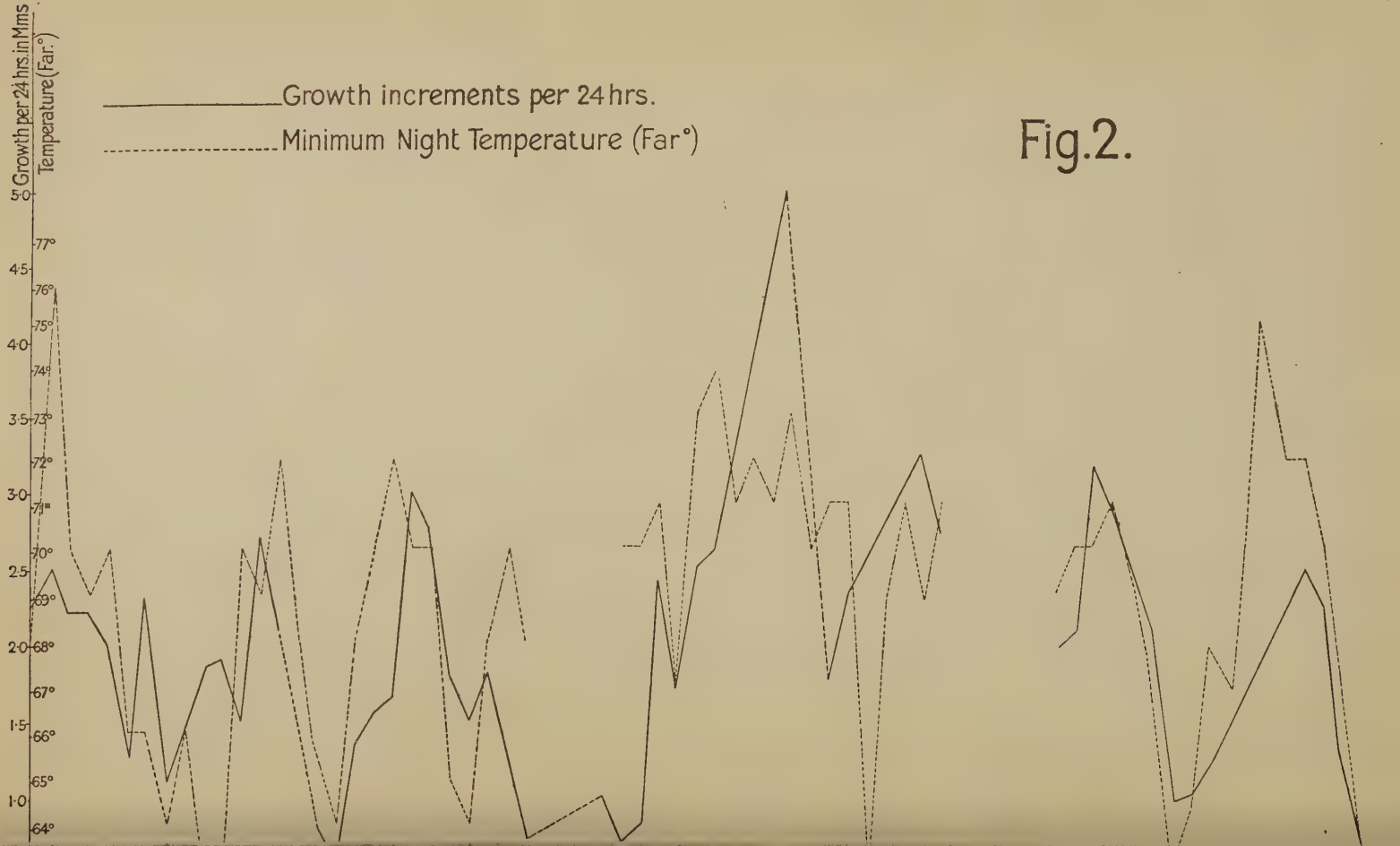

Growth increments per 24 hrs.
Minimum Night Temperature (Far°)
Growth per 24 hrs. in Mms
Temperature (Far.°)
5·0
4·5
4·0
3·5
3·0
2·5
2·0
1·5
1·0
77°
76°
75°
74°
73°
72°
71°
70°
69°
68°
67°
66°
65°
64°

Fig.2.

This fact is of economic importance, for it clearly indicates the difficulty of raising plants during the winter months, and that without sufficient light small-leaved seedlings will be obtained, however high the temperature is kept; in fact, raising the temperature will only encourage stem growth and long, straggling plants. Light is always at a minimum during winter owing to the short days, the low altitude of the sun, and the prevalence of mists, so every effort should be made to secure the absolute maximum available during this period of the year. Improvements in the design of propagating houses to secure this end would seem advisable; also in the future it may be possible to make use of artificial light to supplement the daylight.

Results of Seedling Experiments.

Table VIII.

Expt.	Date of start of Experiment.	Dry Weight.				No. of Leaves.	Leaf Area.	Proportion.	Dry wt. per sq. decimeter.	Stem weight. / Leaf weight.	Average rate of assimilation.	Daily increase in leaf surface.	Da hou of lig
		Leaf.	Stem	Total	Proportn								
1	10/11/16.			.345	1	4	1.83 sq. dec.	1			2.23 mgms. pr sq.dec.per hr.	13.58%	8
2	29/12/16.			.351	1	4	1.41 sq. dec.	0.8					8
3	21/2/17.	1.806	1.133	2.939	8.5	8	7.44 sq. dec.	4.1	.242 gms.	.62	4.56 mgms. pr sq.dec.per hr.	19.02%	11
4	22/4/17.	4.838	3.760	8.598	24.9	10				.78			14
5	11/6/17.	4.590	4.580	9.170	26.6	12	16.85 sq.dec.	9.2	.272 gms.	.99	3.65 mgms. pr sq.dec.per hr.	22.32%	17

From the above Table several facts appear:

1.—The seedlings raised in June gave a dry weight 26 times that of the seedlings started in December.

2.—The leaf area did not increase in the same proportion, hence there is a greater activity of "summer" leaves.

3.—"Summer" leaves are thicker than "spring" leaves as shown by the greater weight per unit area.

4.—In the summer, the proportion of stem weight to leaf weight is higher than in the spring.

The area of leaf surface in experiments 1, 3 and 5, stands in the proportion of 1 to 4.1 to 9.2. The question remains how to account for these differences. Two factors obviously play a part, viz.: temperature and light. It has already been stated that variations in rate of increase of leaf area are correlated with the total amount of light received, but correlation with temperature is also evident. The average temperatures ranging over the period of the experiments 1, 3 and 5 are given in Table XI.

Table IX.

Exp.	Average Temperature.	Proportion.	Average total energy per day calories.	Proportion.	Average intensity of radiation (proportn.).	Average leaf area.	Proportion.
1	69.8°F.=21.0°C.	1	.51	1	1	0.59 sq.dec.	1
3	72.2°F.=22.3°C.	1.06	1.48	2.9	2.2	2.01 sq.dec.	3.4
5	78.2°F.=25.7°C.	1.22	4.23*	8.3	4.05	5.16 sq.dec.	8.7

*A small proportion of the energy was lost to the recorder, owing to the shading of the receiver of the instrument.

The average temperature in experiments 1 and 3 differed only by 1.3°C., while in experiments 1 and 5 it differed by 4.7°C. The differences in average temperature are not large enough to account for the divergencies obtained, and thus intensity and duration of light must be looked upon as the main factors in determining growth in leaf area, and hence dry weight also. Comparing the proportionate total energy column with the proportionate average leaf area, this relation is clearly indicated.

Table X.

Expt.	Average rate of assimilation.	Proportion.	Relative average intensity of radiation.
1	2.23 mgms. per sq. dec. per hour	1	1
3	4.56 mgms. per sq. dec. per hour	2.04	2.2
5	3.65 mgms. per sq. dec. per hour	1.62	4.05

It is seen from Table X. that in experiments 1 and 3 the average rate of assimilation is proportional to the average intensity of radiation, and, remembering that the average temperature differs only by 1.3°C. in the two experiments, it indicates clearly that light intensity must be a limiting factor in experiment 1.

In experiment 5, on the other hand, the average rate of assimilation falls far below the proportionate intensity value, so that something must here be checking the assimilatory activity. It is tentatively suggested that this is due, at least in part, to excessive leaf temperatures resulting from the high intensity of summer illumination.

Thus the following results are indicated:

1.—The average leaf area is proportional to the average total light energy falling on the unit area during the period of the experiment.

2.—The rate of assimilation (neglecting respiration) is proportional to the average intensity of radiation during the period of the experiment. This relation holds good only so far as leaf temperatures are not excessive.

Growth-Rate.

Continuous records of the growth of the main stem of cucumber plants were taken with a self-recording apparatus.

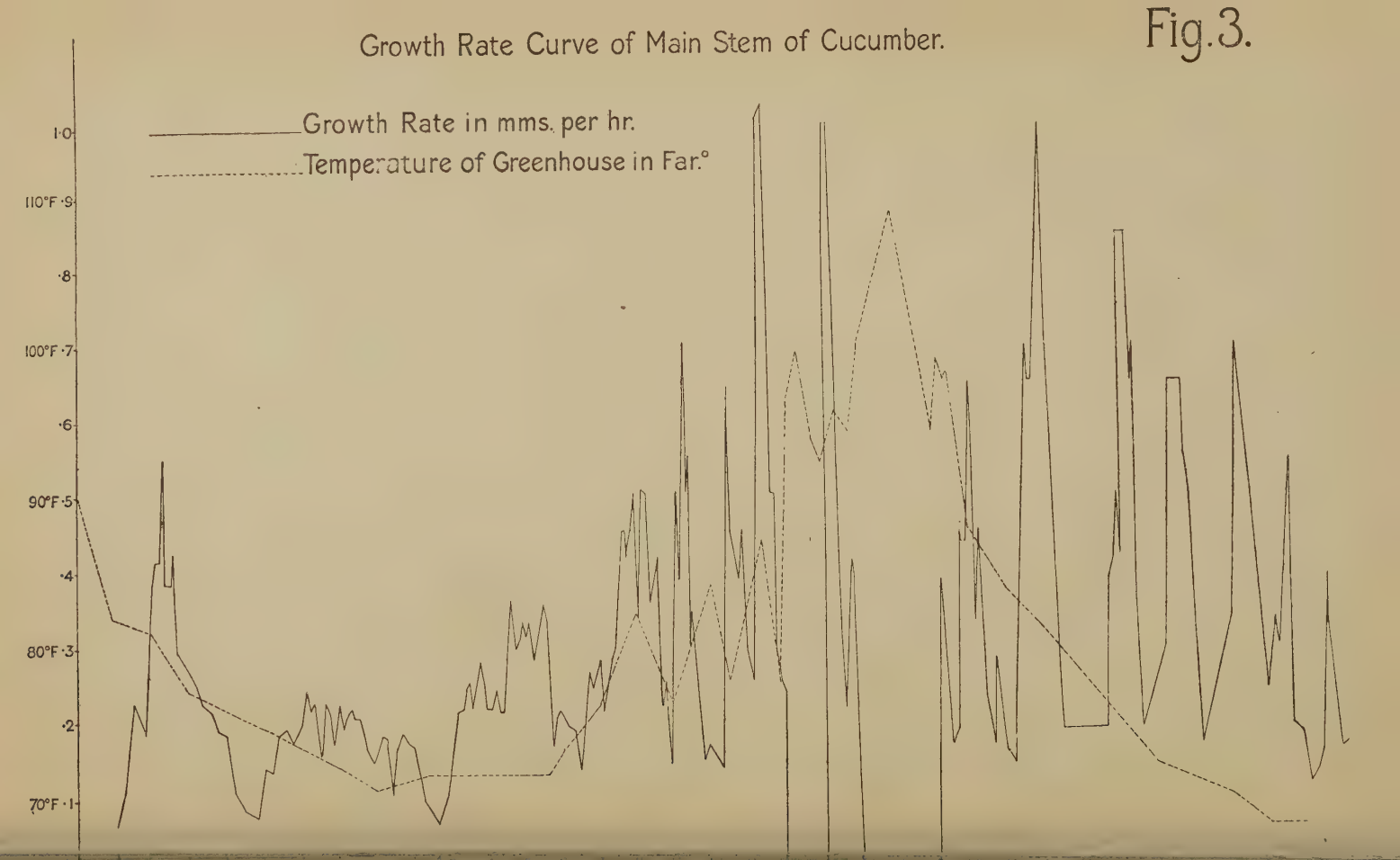
The variations in growth-rate are exceedingly large and rapid. In general the growth-rate follows the temperature, unless the temperature be excessively high. On brilliant days, with a high temperature in the house, the growth-rate rises with the temperature in the morning hours, then ceases altogether for several hours, and is resumed again as the temperature in the house falls (see Fig. 3). Shrinkage of the tissues takes place during the middle of the day, and may amount to several millimetres. When the temperature falls, growth is resumed and rapid elongation of the tissues takes place. In all cases the growth-rate is found to be higher during the day than during the night.

The curve in Figure 3 represents the growth in length of the main stem of a single cucumber plant. The growth curve in Figures 1 and 2 represents the average growth increments of ten axillary shoots selected from plants in one border. The correlation between the growth-rate and fruit production (Figure 1) is seen to be as close as that between growth-rate and minimum temperature (Figure 2).

Leaf-Temperature.

The cause of cessation of growth is bound up with the injurious effects of high temperature. An investigation on this point was made by starting cucumbers in an incubator at constant temperatures, usually 90°F., and at the same time taking a record of the growth-rate. The temperature of the incubator was then rapidly raised to a maximum of 120°F. The growth-rate was found to follow the temperature and to increase rapidly, but when the temperature of the incubator had reached 120°F. and then remained constant, the growth-rate rapidly fell off, and after six hours the plant was dead. Precautions were taken to keep the atmosphere in the incubator saturated with mois-

Fig.3.


Growth Rate Curve of Main Stem of Cucumber.
Growth Rate in mms. per hr.
Temperature of Greenhouse in Far.°
1·0
110°F ·9
·8
100°F ·7
·6
90°F ·5
·4
80°F ·3
·2
70°F ·1

ture the whole time. 120°F. is thus a fatal temperature to seedlings after some hours' exposure even in a saturated atmosphere.

Records were taken of the differences in temperature between leaves and the surrounding air in the green-house, by means of a thermo-couple embedded in the leaf tissue, and another attached to the recording portion of a thermograph.

On April 24th, a brilliant day, with the houses still unshaded, the vents were kept closed the whole day; as a result it was found that the leaves were at least 10°F. higher than the surrounding air. The maximum temperature recorded at the bottom of the house was 110°F., and, even assuming that the temperature at the top was no higher than this, it means that the leaves were exposed for a period of four hours to a temperature well over 120°F. The following day all the leaves were found to be scorched. The temperature of the stem also appears to rise several degrees above the temperature of the air, and this may have unsuspected effects on the rate of transport of food materials formed by the leaves. The importance of keeping down the temperature of the house during bright sunshine is thus clearly indicated.

In general the temperature of the leaf fluctuates very rapidly over a range of from 15° to 10°F.; in fact, the leaf-temperature record gives a very trustworthy picture of the variations in intensity of sunshine. The young leaf is under low intensity of light at a lower temperature than the air by 2 to 4°F., even with the vents closed. This lowering of temperature is due to the effect of transpiration. With the vents wide open, the increased draught causes rapid transpiration of the leaves and the temperature of the young leaf falls 11 to 14°F. below the air temperature. The initial fall in temperature on opening the vents is very striking.

APPENDIX.

Top-Dressings for Cucumber Borders, 1917.

Throughout the Series C. to F. inclusive, top-dressings were given every fortnight from March 23rd to the end of the season, of exactly the same composition as the original borders in each case, no other fertilisers being added at any time. Ten top-dressings were given in all, the amounts of each dressing being as follows :—

Series.	Top-dressing.
C. 1. & C. 4.	1½ barrows straw manure, ¾ barrow of loam, and 1 lb. 2 ozs. lime to each set of 12 plants.
C. 2... ...	1½ barrows straw manure, half barrow of loam, 1 lb. 2 ozs. lime, and 2 lbs. 10 ozs. superphosphate to each set of 12 plants.
C. 3. & C. 6.	1½ barrows straw manure, half barrow of loam, 1 lb. 2 ozs. lime, and 1½ lbs. bone-meal to each set of 12 plants.
C. 5... ...	1½ barrows of straw manure, half barrow of loam, 1 lb. 2 ozs. lime, and 3¾ lbs. basic slag to each set of 12 plants.
D. 1. & D. 4.	Three barrows of loam, and 1½ lbs. lime to each set of 16 plants.
D. 2... ...	Three barrows of loam, 1½ lbs. lime, and 1 lb. 2 ozs. hoofs to each set of 16 plants.
D. 3. & D. 6.	Three barrows of loam, 1½ lbs. lime, and 2 lbs. 4 ozs. bone-meal to each set of 16 plants.
D. 5... ...	Three barrows of loam, 1½ lbs. lime, 1 lb. 2 ozs. hoofs, and 2 lbs. 4 ozs. bone-meal to each set of 16 plants.
E. 1. & E. 4.	1½ barrows loam, 1½ barrows manure, 1½ lbs. lime to each set of 16 plants.
E. 2... ...	1½ barrows loam, 1½ barrows manure, 1½ lbs. lime, and 1 lb. 2 ozs. hoofs to each set of 16 plants.
E. 3. & E. 6.	1½ barrows loam, 1½ barrows manure, 1½ lbs. lime, and 2 lbs. 4 ozs. bone-meal to each set of 16 plants,
E. 5... ...	1½ barrows loam, 1½ barrows manure, 1½ lbs. lime, 1 lb. 2 ozs. hoofs, and 2 lbs. 4 ozs. bone-meal to each set of 16 plants.
F. 1. & F. 4.	Two barrows loam, 1 barrow manure, and 1½ lbs. lime to each set of 16 plants.
F. 2... ...	Two barrows loam, 1 barrow manure, 1½ lbs. lime, and 1 lb. 2 2 ozs. hoofs to each set of 16 plants.
F. 3. & F. 6.	Two barrows loam, 1 barrow manure, 2 lbs. 4 ozs. bone-meal, and 1½ lbs. lime to each set of 16 plants,
F. 5... ...	Two barrows loam, 1 barrow manure, 1½ lbs. lime, 1 lb. 2 ozs. hoofs, and 2 lbs. 4 ozs. bone meal to each set of 16 plants.

Dates of Sowing, Potting, Planting, Picking, &c., 1917.

Crop.	Sown.	Pricked off.	Potted into 60's.	Potted into 32's.	Planted out in borders.	Mulching.	First Top Dressing.	First Fruit Picking.	Last Fruit Picking.
Tomatoes (Isolation House) ...	Jan. 3	Jan. 14	Feb. 20	——	April 4	May 30	June 13	June 6	Oct. 20
Tomatoes (Large Houses) ...	Jan. 3	Jan. 14	Feb. 20	——	Mar 19-21	May 30-31	June 13	June 1	Oct. 17
Cucumbers in borders	Dec. 29, 1916.	Jan. 2	Jan. 6	Jan. 29	Feb. 26-27	——	Mar. 23	April 2	Aug. 27

Chemical analyses of soils of tomato plots, taken November, 1916. Rothamsted Laboratory.

Plots, 1916.	TREATMENT.	Nitrogen.		"Total" P_2O_5 per cent.		"Available" P_2O_5 per cent.		"Total" K_2O per cent.		"Available" K_2O per cent.		CaO per cent.		Carbonates expressed as $CaCO_3$ per cent.	
U5	Complete Artificials alone	0.19	0.22	0.29	0.30	0.14	0.17	0.34	0.34	0.08	0.09	0.97	1.59	0.6	1.7
T5	Complete Artificials alone	0.25		0.30		0.20		0.34		0.09		2.20		2.8	
U6	Complete Artificials less phosphates ...	0.20	0.20	0.30	0.29	0.15	0.14	0.38	0.36	0.02	0.02	0.82	0.81	0.7	0.7
T6	Complete Artificials less phosphates ...	0.20		0.28		0.12		0.33		0.02		0.80		0.7	
U7	Complete Artificials less nitrogen ..	0.18	0.19	0.31	0.33	0.14	0.15	0.38	0.38	0.03	0.03	1.05	1.30	1.2	1.3
T7	Complete Artificials less nitrogen ...	0.20		0.36		0.17		0.38		0.03		1 55		1.4	
U8	Complete Artificials less potash ...	0.21	0.20	0 30	0.30	0.14	0.14	0.35	0.33	0.02	0.02	1.13	1.08	1.0	1.0
T8	Complete Artificials less potash ...	0.19		0.30		0.13		0.30		0.02		1 02		0.9	

Mechanical analyses of soils of tomato plots, taken November, 1916. Rothamsted Laboratory.

	U5 %	T5 %	U6 %	T6 %	U7 %	T7 %	U8 %	T8 %
Fine Gravel ...	2.6	3.3	4.0	2.4	2.6	3.2	3.0	4.0
Coarse Sand ...	23.7	22.4	24.6	24.2	24.0	21.4	23.3	24.4
Fine Sand ...	21.9	20.4	25.3	22.0	25.0	26.1	27.0	26.7
Silt	25.0	24.0	21.5	25.1	22.2	19.1	19.5	19.1
Fine Silt	9.4	11.4	8.5	8.2	11.2	11.7	10.9	9.9
Clay	5.0	3.0	5.5	5.5	2.9	2.7	4.6	3.3
Loss on Ignition...	9.1	10.5	8.6	8.9	8.5	11.4	8.9	8.5

Tomato Manurial Experiments. Houses 3 & 4. Series J & K.

Eight equal plots of 32 square yards were set out in each house and on each plot 108 plants were grown. The different treatments were as follows :—

Plot 1. Standard manurial treatment consisting of 2 lbs. lime, 14 lbs. straw manure, ½ lb. bone-meal, ½ lb. bone-flour, ½ lb. ground hoofs, and ½ lb. sulphate of potash per square yard.

Plot 2. Half the treatment in Plot 1.

Plot 3. Double the treatment in Plot 1.

Plot 4. *Complete artificials, lime, basic slag, superphosphate, sulphate of ammonia, nitrate of soda, and sulphate of potash, equivalent in analytical value to the materials given in Plot 2, plus 7 lbs. straw manure per square yard.

Plot 5. *Complete artificials as in Plot 4, but no straw manure.

Plot 6. *Complete artificials as in Plot 5, but omitting phosphates.

Plot 7. *Complete artificials as in Plot 5, but omitting nitrogen.

Plot 8. *Complete artificials as in Plot 5, but omitting potash.

*The quantities given in Plots 4 to 8 were as follows :—

Plot 4. **Before planting.** 1 lb. lime, 7 lbs. straw manure, 0.4 lb. basic slag, and 0.1 lb. sulphate of potash per square yard.

After planting in four equal instalments. 0.2 lb. sulphate of ammonia, 0.2 lb. nitrate of soda, 0.5 lb. superphosphate, and 0.2 lb. sulphate of potash per sq. yd.

Plot 5. Same as Plot 4 with the omission of straw manure.

Plot 6. Same as Plot 4 omitting straw manure, basic slag, and superphosphate.

Plot 7. Same as Plot 4 omitting straw manure, nitrate of soda, and ammonium sulphate.

Plot 8. Same as Plot 4 omitting straw manure and sulphate of potash.

No mulching or top-dressing other than the above was given in the Series J and K. (Corresponding to Series T and U respectively of 1916.)

For analyses of various materials used see Appendix, Second Annual Report 1916.

STATISTICAL ADDENDA.

Cucumbers.	
Number of experimental borders	24
Total number of plants	432
Equivalent number of plants per acre	3360
Total fruit picked—in tons	8.1
Equivalent tonnage per acre	63
Average yield of fruit in lbs. per plant	42
Total number of flats* sent to market	† 504
Average weight of fruit per flat in lbs.	36
Number of flats per foot run of house	1.17

* Flats are baskets in which cucumbers are packed according to size, so that a specified number of dozens fills the basket when packed with hay and tissue paper in four layers. The internal dimensions of a flat are 21 ins. by 15 ins. by 9 ins.

† Consisting of 6 2-dozens, 74 2½-dozens, 182 3-dozens, 106 3½-dozens, 88 4-dozens, and 48 crooks and smalls.

Tomatoes.	
Number of experimental plots	86
Area of plots in parts of acre	0.3086
Total number of plants	4838
Equivalent number of plants per acre	15680
Total fruit picked—in tons	10.8
Equivalent tonnage per acre	35
Average yield of fruit in lbs. per plant	5
Total number of strikes* sent to market	† 2016
Weight of fruit per strike in lbs.	12

* Strikes are baskets holding 12 lbs. of fruit, graded according to size and quality from Pinks down to Chats.

† Consisting of 357 Pinks, 617 Pink and Whites, 677 Blues, 239 Whites, and 126 Blue and Whites.

For sizes of the Culture Houses, and the arrangement of the experimental borders and plots, see frontispiece.

Notes on the weather, from the grower's point of view, of the Season 1917.

JANUARY.—This month was very cold, generally dull, and somewhat foggy. On the whole it was a bad month for raising plants. The insufficient sunlight, and the extra artificial heat required, tended to make the seedlings weak.

FEBRUARY.—Cold and dull days prevailed during the greater part of February, the nights being usually bright and frosty. The conditions for the growth of seedlings were very similar to those of January, the slowness of growth being very noticeable.

MARCH.—In general the days were cold and windy, and the nights bright and frosty. During the latter half of the month under the influence of an increased amount of sunshine the crops improved rapidly, making up to a certain extent for the growth lost during the two preceding months.

APRIL.—During the first half of the month there was an average amount of sunlight associated, however, with prevalent cold winds. The 16th was a remarkable day. In the morning there was brilliant sunshine, together with a cold north-west wind; in the afternoon a thunderstorm occurred, accompanied by snow, sleet and hail. This was followed by a very cold night. After this the weather improved generally, and bright, hot days were the rule to the end of the month.

MAY.—Generally, this month was hot and dry, with an average amount of sunlight; crops grew rapidly, and the setting of fruit was good.

JUNE.—This was similar to May, but the nights were rather cold for the time of year.

JULY.—Taken as a whole the weather of July was favourable to crops. There were, however, several extremely rapid changes from hot, dry, sunny days to cold, wet, dull ones. During the latter half of the month the rainfall was excessive. Tomato "mildew" (*Cladosporium fulvum*) made its appearance about this time and spread rapidly, and all young growth was notably weak.

AUGUST.—This month was similar to July. During the first fortnight the rainfall was above the average. After the 20th there was a considerable fall in temperature, which had the effect of giving quite an autumnal appearance to glass-house crops.

SEPTEMBER. The days were generally warm, sunny, and dry. These conditions were very favourable to all late crops.

OCTOBER.—This month was very similar to September.

Many times during the season the barometer showed extremely rapid rises and falls, often in the course of a few hours. Notable features of the season were the prevalence of Cucumber Leaf Blotch (*Cercospora melonis*) and of Chrysanthemum Rust (*Puccinia compositarum*).

On the whole, there was considerably less Tomato "mildew" (*Cladosporium fulvum* than during the preceding season.

Meteorological Records, 1917.

Month.	Rain.		Average outside Temperatures.		Bright Sunshine.
	Total fall. 5 inch Funnel Gauge.	No. of Rainy Days.	Day Maxm. °F.	Night Minm. °F.	Daily average in hours.
	Inches.				
January	1.3	16	37.3	31.6	0.73
February	0.8	12	39.2	29.3	1.61
March	1.5	17	43.7	31.2	2.51
April	2.1	12	49.8	33.8	4.85
May	2.0	8	67.3	46.8	7.38
June	2.0	11	71.7	52.0	7.06
July	4.1	11	70.6	53.3	7.00
August	4.9	22	66.9	54.8	5.09
September	1.8	10	66.1	50.8	5.19
October...	4.1	19	53.7	39 2	4 69
November	1.5	16	51.1	40.4	1.62
December	0.8	15	40.4	30.4	2.03
Total or Mean... ...	26.9	169	54.8	41.1	4.15